Hall Ticket Number:

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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (Mech. Engg.) III Year II-Semester Main Examinations, May-2017

Heat Transfer

Time: **3** hours Max. Marks: **70**

*Note: 1. Answer **ALL** questions in **Part-A** and any **FIVE** from **Part-B***
2. Heat transfer data book is permitted 3. Missing data, if any may be assumed.

Part-A (10 × 2 = 20 Marks)

1. Write the 2-D, transient heat conduction equation in differential form for the circular rod with a volumetric heat generation in it. Assume constant thermo-physical properties of rod material.
2. With a neat sketch, explain the meaning of critical insulation thickness for a sphere.
3. Write two conditions of the system for which the lumped heat capacity analysis is applicable.
4. List out different practical applications of fins.
5. Define thermal boundary layer thickness (δ_T). Show with a neat sketch the effect of fluid flow velocity on it.
6. Briefly explain dimensional analysis as applied to heat transfer.
7. Show that the shape factor between two concentric spheres having diameters 'a' and 'b' for inner spheres and outer spheres respectively is $F_{12} = \left(\frac{a}{b}\right)^2$.
8. Explain with a neat sketch the Planck's law and write its main use.
9. Distinguish between drop wise and film wise condensation.
10. Draw the temperature variation of hot and cold fluids in a parallel flow heat exchanger.

Part-B (5 × 10 = 50 Marks)

11. a) Compute the heat loss per square meter surface area of a 40 cm thick furnace wall having surface temperatures of 300^{0}C and 50^{0}C if thermal conductivity k of the wall material is given by $k = 0.005T - 5 \times 10^{-6}T^2$ where T = temperature in °C. [3]

    b) Steam at 320°C flows in a stainless steel pipe (k =15 W/m-°C) whose inner and outer diameters are 5 cm and 5.5 cm, respectively. The pipe is covered with 3 cm thick glass wool insulation (k=0.038 W/m-°C). Heat is lost to the surroundings at 5°C by convection, with heat transfer coefficient of 15 W/m^2-°C. Taking the heat transfer coefficient inside the pipe to be 80 W/m^2-°C, determine the rate of heat loss from the steam per unit length of the pipe. Also determine the temperature drops across the pipe shell and the insulation. [7]

12. a) An aluminium fin (k = 200 W/mK) 3 mm thick and 7.5 cm long produces from a wall at 300^{0}C the ambient temperature is 50^{0}C with h=10W/m^{2}K. Compute the heat loss from the fin per unit depth of material. Also calculate its efficiency and effectiveness. [5]

    b) A large aluminum rod of 10 cm diameter is initially at uniform temperature (= 400°C). Suddenly it is exposed to a convection environment at 90°C with heat transfer coefficient, h=1400 W/m^2°C. How long does it take the centerline temperature to drop to 180°C? (Properties of Aluminium: $\propto = 8.4 \times 10^{-5} m^2/s$, C_p=0.9 kJ/kgK, ρ = 2700 kg/m^3.) [5]

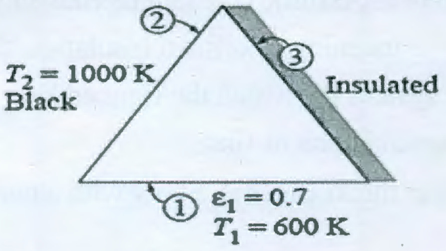
13. a) What is Reynold's analogy? [3]

    b) A vertical pipe of 20 cm outer diameter, at a surface temperature of 100^{0}C is in a room where the air is at 20^{0}C. The pipe is 3m long. What is the rate of heat loss per meter length of the pipe? [7]

Contd... 2

14. a) Define the following; [4]
i) Total hemispherical emissivity. ii) View factor.

b) A furnace is shaped like a long equilateral triangular duct, as shown below. The width of each side is 1 m. The base surface has an emissivity of 0.7 and is maintained at a uniform temperature of 600 K. The heated left-side surface closely approximates a black body at 1000 K. The right-side surface is well insulated. Assume the shape factor from any surface to any other surface in the enclosure as 0.5. [6]
i) Draw the thermal network diagram.
ii) Determine the rate at which heat must be supplied to the heated side externally per unit length of the duct in order to maintain these operating conditions.



15. a) Draw the boiling curve and identify the different boiling regimes and briefly explain characteristics of each regime. [4]

b) Hot oil is to be cooled by water in a 1-Shell pass and 8-tube passes heat exchanger. The tubes are thin walled and made up of copper with internal diameter of 1.5 cm. Length of each tube is 5 m. and overall heat transfer coefficient is 310 W/m^{2}K. Water flows through tubes at a rate of 0.2kg/s and oil through the shell at a rate of 0.3kg/s. Water and oil entry at temperatures of 20^{0}C and150^{0}C respectively. Determine rate of heat transfer in heat exchange4r and outlet temperatures of the water and the oil. [6]

16. a) A 1 mm diameter wire is maintained at a temperature of 400^{0}C and exposed to a convection environment at 40^{0}C with heat transfer coefficient h=120 Wm^2-^{0}C. Calculate the thermal conductivity that will just cause an insulation thickness of 0.2 mm to produce a critical radios. Also, calculate the heat transfer experienced by the bare wire per meter of length. [5]

b) A steel ball, 5 cm in diameter and initially at a temperature of 450^{0}C in suddenly placed in a controlled environment in which temperature is maintained at 100^{0}C. Calculate the time required for the ball to attain a temperature of 150^{0}C taking the following properties. For steel : k = 35W/mk, C_p = 0.46kJ/kgK, ρ = 7800kg/m^3 and Convective heat transfer coefficient = 10 W/m^{2}K. [5]

17. Answer any *two* of the following:

a) Define the following: [5]
i) Reynolod's number ii) Grashof number iii) Prandtl number
iv) Nusselt number v) Fouling factor

b) What is Radiation shield and show that by placing ration shield in between two parallel surfaces at temperatures T_1 and T_2 respectively is halved? Assume emissivity of two parallel plates and shield are equal. [5]

c) Explain the terms NTU, and LMTD, and their significance in heat exchanger design. [5]